MASTER OF SCIENCE
IN
MECHANICAL ENGINEERING

THE USE OF NEURAL NETWORKS AS A METHOD OF CORRELATING THERMAL FLUID DATA TO PROVIDE USEFUL INFORMATION ON THERMAL SYSTEMS

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A study on the use of neural networks as a method of correlating thermal fluid data to provide useful information on thermal systems was conducted using a neural network code package. Two separate thermal fluid systems were analyzed: tube bank data with variable geometries and tube bank boiling data with variable parameters. Both studies show the effectiveness of neural networks as a viable alternative to the current practice of correlating data. This is achieved by displaying a reduction in error, requiring fewer assumptions, and providing an easier method of devising predictions and correlations.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Modeling and Simulation

KEYWORDS: Neural Networks, Data Correlation, Thermal Systems

MODELING THE PROGRESSIVE FLOODING CHARACTERISTICS OF THE ARLEIGH BURKE CLASS DESTROYER USING SIMSMART AND EXCEL

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The goal of this thesis is to contribute further to the development of a design tool for the modeling of dynamic progressive flooding in ships. In an earlier thesis, LT Thomas Anderson, USN, modeled a generic, mathematically-describable hull form; in this thesis the work is extended by applying his methods and generating new ones in order to accurately model an actual ship hullform, (the Arleigh Burke (DDG-51)), in a progressive flooding scenario. A secondary goal is to create an organized process, complete with any necessary programs or software, which can be applied to any hullform in the future in order to create a progressive flooding model. These goals contribute to the ultimate goal of creating a viable design tool that will allow the Naval Architect to evaluate the potential of a prototype vessel to withstand damage in a progressive flooding scenario.

DoD KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Ship Design, Survivability, Flooding

VALIDATION OF LOW OBSERVABLE STACK EDUCTOR DESIGN FOR GAS TURBINE EXHAUST SYSTEMS

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The performance of several configurations for an enhanced mixing eductor was measured in a one-fifth scale, cold flow facility. All the configurations consisted of 16 high aspect-ratio nozzles. The impact on the exit flow and secondary flow entrainment of several variations was measured. Specifically, the influence of nozzle height on the tendency of the high-speed jets to coalesce was characterized along with the impact of the mixing tube inlet shape on aerodynamic performance. Also, the entire eductor was placed inside the shroud to ascertain the reduction in secondary flow resulting from the depressed static pressure from the shroud inlet blockage. A qualitative understanding of the flow field into the shroud and mixing tube was obtained from a smoke technique. A total pressure rake was designed and manufactured for more efficiently measuring the exit velocity profile out of the mixing tube. An analysis of the results is provided along with entrainment projections for hot flow.

DoD KEY TECHNOLOGY AREAS: Electronic Warfare, Modeling and Simulation, Other (Signatures)

KEYWORDS: Modeling and Simulation, Gas Turbine Exhaust, Eductors, Mixing, Cold Flow Testing

ACOUSTICALLY FORCED HEAT TRANSFER FROM A TUBE BANK

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Experimental work was carried out on the steady state heat transfer behavior from a tube bank in a zero mean oscillatory flow. The oscillatory flow across the tube bank was created by an acoustic field inside an isolated resonant chamber. The tube bank was represented by smooth walled cylinders placed parallel to each other, with their plane normal to the direction of fluid oscillation, similar to the arrangement found in many heat exchangers. The spacing between the cylinders was varied to examine the effects of boundary layer interference on the heat transfer behavior . Heat transfer correlations were developed in the form of Nusselt number as a function of the streaming Reynolds number for each tube spacing. This experimental study is relevant to the design of heat exchangers for thermoacoustic engines.

DoD KEY TECHNOLOGY AREAS: Electronics, Manufacturing, Science, and Technology (MS&T)

KEYWORDS: Thermoacoustic Engines, Heat Exchangers, Oscillatory Flows, Heat Transfer, Tube Bank

FORMATION CONTROL FOR MULTI-VEHICLE ROBOTIC MINESWEEPING

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Current methods of minefield reconnaissance and clearance operations prove to be tedious, time consuming, expensive, and dangerous. In an effort to find an effective low cost solution, the U.S. Navy is considering using fleets of robotic underwater vehicles equipped with detection sensors and/or magnetic and acoustic minesweeping devices. To ensure maximum sweeping of the minefield, all vehicle movements are coordinated through a supervisor vehicle. Here, a computer simulation was conducted using a lawnmower minesweeping pattern. As the minefield is swept, vehicles are lost to mine detonations and the supervisor re-tasks all remaining vehicles. The algorithm for track control and vehicle reconfiguration was studied and evaluated.

DoD KEY TECHNOLOGY AREAS: Sensors, Surface/Under Surface Vehicles - Ships and Watercraft, Modeling and Simulation, Other (Minesweeping)

KEYWORDS: Autonomous Underwater Vehicles, Unmanned Underwater Vehicles, Robotics, Minesweeping

AN EXPERIMENTAL APPROACH FOR STUDYING CREEP BEHAVIOR OF MODEL PLANAR INTERFACES

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An apparatus for measuring the steady state creep behavior of interfaces in aluminum-silicon-aluminum multilayered specimens has been assembled. In the experiment scheme, a double-shear specimen geometry was used to load the interfaces in a state of nominally constant shear. The deformation kinetics for interfacial sliding during constant shear stress creep experiments were measured for various applied interfacial shear stress levels and temperatures. Interfacial shear strain rates were measured using displacement and capacitance gauges. The planar interfaces between the aluminum and silicon layers were prepared by diffusion bonding. Preliminary results indicate that interfacial sliding occurs via time-dependent relaxation mechanisms and that there is a threshold stress for interfacial sliding, in agreement with previous work on lead-Quartz and lead-nickel interfaces. The preliminary values obtained for the activation energy for interfacial sliding in this aluminum-silicon-aluminum multilayered system is low (~30KJ/mol), and is believed to be due to interfacial diffusion of aluminum atoms. In general, the activation energy is thought to be dependent on the structure and chemistry of the interface.

DoD KEY TECHNOLOGY AREAS: Materials, Processes, and Structures, Electronics

KEYWORDS: Interface Sliding, Diffusion Bonding, and Creep

THE EXPERIMENTAL EVALUATION OF A DGPS BASED NAVIGATIONAL SUITE IN THE ARIES AUV

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Autonomous Underwater Vehicles (AUV) currently use varying methods for navigation, but incorporating GPS into those methods is becoming a popular technique. This thesis experimentally evaluates the configuration and implementation of the Navigational Suite within the Naval Postgraduate School's AUV, the Acoustic Radio Interactive Exploratory Server (ARIES). Specific attention is given to the configuration of the vehicle's newly completed Differential Global Positioning System (DGPS). A brief discussion of DGPS and Extended Kalman Filter theory continues with a description of the make-up and applications of components within the Suite. Details of a series of experiments, which begins with evaluation of the DGPS setup, then qualifies the system in an open-water environment, and finally qualifies the DGPS in conjunction with newly configured ARIES Navigational Filter, provide an examination of the Suite's performance.

DoD KEY TECHNOLOGY AREAS: Command, Control and Communications, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Autonomous Underwater Vehicles, Differential Global Positioning System, Extended Kalman Filtering, Underwater Navigation, Robotics